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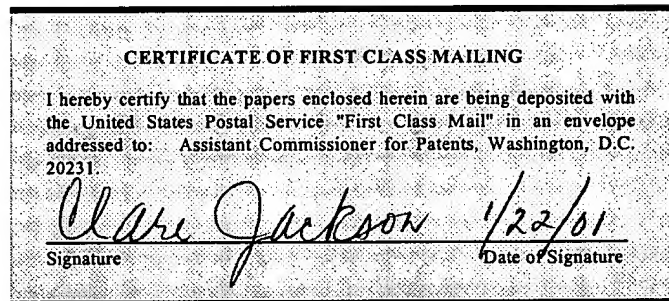
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Merrill et al
Application No.: 09/329,502
Filed: June 10, 1999
Examiner: T. Dang
Group No.: 1764
For: AROMATIC CONVERSION PROCESS EMPLOYING
 LOW SURFACE AREA ZEOLITE Y

Via First Class Mail

Assistant Commissioner
for Patents
Washington, D.C. 20231



Sir:

APPEAL BRIEF

This is an appeal from the decision of the Primary Examiner finally rejecting claims 1-6, 8-13, and 18-20. This Brief is submitted in triplicate with the statutory fee of \$310.00.

Real Party in Interest

The real party in interest is Fina Technology, Inc., a Delaware corporation, as recorded by the assignment filed and recorded June 10, 1999, at Reel/Frame 010037/0639 in the records of the Patent and Trademark Office.

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Related Appeals and Interferences

There are presently no related appeals or interferences before the Board of Patent Appeals and Interferences.

Status of Claims

The claims pending in this application are claims 1-6, 8-13, and 15-21. Claim 21 and claims 15-17 dependent therefrom are subject only to a rejection of double patenting based upon the claims in U.S. Patent No. 5,955,642. Appellants are submitting concurrently herewith a terminal disclaimer against Patent No. 5,955,642, and accordingly, claims 21 and 15-17 would now appear to be in condition for allowance. In view of the terminal disclaimer, the claims on appeal are claims 1-6, 8-13, 18-20 and these claims are reproduced in Exhibit A. No claim is allowed other than claims 21 and 15-17 which should be in condition for allowance upon entry of the terminal disclaimer.

Status of Amendments

An Amendment Under 37 CFR 116 was filed on October 25, 2000, (received October 30, 2000) and has been entered subject to the filing of an appeal by the Advisory Action dated November 17, 2000.

Summary of the Invention

The invention called for in the claims on appeal involves an alkylation/transalkylation process involving the alkylation of benzene with a C₂-C₄ alkylating agent and the liquid phase transalkylation of benzene and a polyalkylated aromatic component resulting from the alkylation reaction over a high porosity zeolite-Y molecular sieve. The high porosity zeolite-Y as actually

used in the transalkylation reaction zone is characterized as having a silica/alumina ratio within the range of 2-5, a pore size greater than 7 and up to about 8 Angstroms, and a surface area of no more than 500 m²/g. Preferably, the high porosity zeolite Y molecular sieve employed in the transalkylation zone has a surface area of about 400 m²/g or less and more preferably a surface area within the range of 350-400 m²/g. The surface area of the zeolite-Y is an indicator of its porosity and provides an inverse measurement of its porosity with the surface area being inversely proportionate to porosity.

The high porosity low surface area zeolite Y is contrasted with standard zeolite Y catalysts commonly employed in transalkylation reactions which can range in surface area from more than 600 m²/g to as high as 700-800 m²/g. As shown by the experimental work described in appellants' specification at pages 23-25, the use of a high porosity zeolite Y having a surface area of 380 m²/g provides enhanced stability over time when compared with a conventional zeolite Y having a surface area of about 625 m²/g. The polyalkylated aromatic component supplied to the transalkylation reaction zone derives from the output of an alkylation reaction zone containing a molecular sieve aromatic alkylation catalyst having an average pore size which is less than the average pore size of the high porosity zeolite Y. A feedstock comprising benzene and a C₂-C₄ alkylating agent is supplied to the alkylation reaction zone which is operated under conditions to produce alkylation of the benzene by the alkylating agent in the presence of the molecular sieve alkylation catalyst. The resultant alkylated product comprises a mixture of monoalkylated and polyalkylated aromatic components. The alkylation product from the alkylation reaction zone is supplied to an intermediate recovery zone for the separation and recovery of a monoalkylbenzene, *e.g.* ethylbenzene, from the alkylation product, together with the recovery of a polyalkylated

aromatic component employing a dialkylbenzene, *e.g.* diethylbenzene. The polyalkylated aromatic component is employed in at least a portion of the feedstream supplied to the transalkylation reactor.

Prior Art

The prior art references relied upon in rejecting the claims under 35 U.S.C. § 103 are set forth below.

U.S. Patent No. 5,324,877 to West et al; and

EP 467,007 to Butler.

Issues

The issues in this appeal are as follows:

1. Whether claims 1-6, 8, and 9 are unpatentable under 35 U.S.C. § 103 in view of the patent to West et al standing alone or alternatively in view of admitted prior art;¹ and
2. Whether claim 10-13 and 18-20 are patentable under 35 U.S.C. § 103 in view of West et al, further in view of Butler (EP 467,007);

Grouping of Claims

In the argument presented in this Brief, all of the claims do not stand or fall together. In addition to the arguments applicable to all of the claims, additional arguments for patentability are made with respect to claims 10-13, 18-20, and also claims 2, 3, and 20.

¹ Original claim 7, which was rejected only under 35 U.S.C. § 103, has been incorporated into claim 1 by the Amendment under 35 U.S.C. § 116. Thus, the original rejection under 35 U.S.C. § 102 is no longer in issue.

Appellants' Arguments

Each of appellants' independent claims require the use in the transalkylation zone of a high porosity zeolite Y having a silica/alumina ratio within the range of 2-5, a surface area of no more than 500 m²/g, and a pore size greater than 7 and up to about 8. The pore size of the high porosity zeolite Y is greater than the pore size of the molecular sieve employed in the alkylation reaction zone. As addressed in detail below, the patent to West discloses a broad spectrum of molecular sieves, some of which include zeolite Y, which have broad ranges of surface areas, silica/alumina ratios, and pore sizes. Some fall within the recitations called for in appellants' claims and some do not. As a practical matter, it is not possible to arrive at the requisite parameters called for in appellants' claims only by selecting the different features involved from West without a consideration of appellants' disclosure. However, even if one were to assemble these different features into one zeolite Y and arrive at a zeolite Y of the requisite silica/alumina ratio and the requisite surface area, one does not arrive at a zeolite Y which West discloses for use in a transalkylation reaction. Instead, this composite zeolite Y as assembled from the diverse teachings of West is a precursor material. This precursor is not used in the West transalkylation reaction zone. It is used to prepare the final molecular sieve actually used in the transalkylation reaction zone. Thus, as developed in more detail below, if one of ordinary skill in the art were to pick a zeolite Y having a surface area of less than 500 as specified in appellants' claims, this is not the zeolite Y catalyst actually used in the transalkylation reaction. Instead, this zeolite Y in West is treated before use in a manner which will substantially increase the surface area to a value greater than the maximum 500 m²/g allowed in appellants' independent claims 1, 10, and 18.

Turning now specifically to the West disclosure and recalling that the Examiner's comments directed to West are with respect to the West starting material prior to its hydration which would result in a substantial increase in surface area, it will be noted that the zeolite Y catalyst employed in the invention transalkylation reaction zone, having a silica/alumina ratio within the range of 2-5, a pore size greater than 7 and up to about 8 Angstroms, and a surface area of no more than 500 m²/g, is significantly different than the zeolite Y described in West. First, while West, near the top of column 6, specifies a surface area of at least 350 m²/g, this is clearly a bottom limit, and as a practical matter, West discloses the use of a modified zeolite Y having a much greater surface area between 500-700 m²/g. Further, the silica/alumina mole ratio of zeolite Y in West et al is disclosed to range from about 4.5 to 35 and preferably is dealuminated so that the silica/alumina ratio would be well above appellants' 2-5 range. Finally, zeolite Y is only one of the crystalline molecular sieves employed in West. Other molecular sieves include zeolites beta, X, omega, and mordenite as well as molecular sieves such as ZSM-5 and silicalite. While certain of the zeolite disclosed in West would have a pore size within the range of 7 to 8 Angstroms, other would appear to have pore sizes substantially below this level, and it is evident that West attributes no importance to the pore size of the zeolite employed in the transalkylation reaction zone. Thus, it is clear that the use of a high porosity zeolite Y having the requisite pore size, silica/alumina ratio and surface area as called for in appellants' claims cannot be inferred from the West disclosure standing alone. Instead, this is possible only when the West disclosure is reviewed in hindsight considering appellants' specification as a road map to pick individual components from West and assemble them in an effort to arrive at Applicants' claims.

As noted above, zeolite Y is but one of many zeolites proposed for use in West in arriving at the catalyst component disclosed there. Various forms of zeolite Y are proposed as the starting

molecular sieves for use in preparing the West catalyst. These various forms of zeolite Y are identified as steam-stabilized Y zeolites, dealuminated Y zeolites, and ultra-hydrophobic zeolites. Any one of these three types of Y zeolites can be used in West as the starting material from which the alkylation (or transalkylation) catalyst can be prepared. In any case, the catalyst actually used in the transalkylation process is one in which the zeolite Y has been hydrated by an amount above 3.5 wt.% water, with the water content ranging up to 25 wt.% and preferably from 5-15 wt.% or 5-10 wt.%. One of the three modified zeolite Y catalysts in West is defined by reference to U.S. Patent No. 4,401,556 and UK Application No. 2,014,970 in terms of a number of factors including a surface area of at least 350 m²/g. with a specific surface area delineated as being between 500 and 700 m²/g. Presumably, the other zeolite Y catalysts or molecular sieves disclosed in West as starting materials would have similar surface areas up to or in excess of 700 m²/g since most zeolite Y catalysts range in surface area from 600 m²/g to perhaps 800 m²/g.

Regardless of the starting material, the basic zeolite Y catalyst used as the starting material is heavily hydrated in order to arrive at the final product which is actually used in the West transalkylation procedure. Hydration of the zeolite Y precursor can be expected to have two effects. First, the incorporation of the water molecules into the crystal structure of the zeolite will decrease the porosity of the zeolite. Correlated in terms of surface area, the heavy hydration of the molecular sieve following the teachings of West would result in a substantial increase in surface area. Recalling that the preferred ultra-hydrophobic zeolite Y used as a starting material has a surface area between 500 and 700 m²/g, obviously the incorporation of water in amounts typically ranging up to 25 wt.% , and preferably in amounts up to 10-15 wt.%, will have a profound impact on porosity, *i.e.*, reducing porosity, with a corresponding increase in surface area. In fact, this phenomenon is relied upon in the West procedure as described in the first full paragraph of column

8 of West. There it is stated that the added water absorbs onto active sites in the molecular sieve, thereby deactivating them. When it is recognized that a water molecular has a kinetic diameter of about 2.6 Angstroms, nearly one-half that of benzene (5.85 Angstroms), it can be seen that the hydration of the zeolite Y starting material will have a profound impact upon its porosity. Even assuming one following the teachings of West starts out with a zeolite Y molecular sieve having a surface area near the minimum proposed in the definition for ultra-hydrophobic zeolite Y, because of the heavy hydration, the results in terms of the surface area of the catalyst as actually used in the transalkylation process will, of course, be substantially greater.

As indicated earlier, West references U.S. Patent No. 4,401,556 and UK Application No. 2,014,970 for a definition of "ultrahydrophobic Y zeolite." Thus, West states at the bottom of column 5: "According to these references, a UHP-Y zeolite is defined as a zeolite having . . . a surface area of at least 350 m²/g . . ." These two references are incorporated by reference in West for a disclosure of the UHP-Y zeolite. These patents call for surface areas of at least 350 m²/g and disclose that the actual UHP-Y zeolites involved have surface areas well above this figure. In UK '970, the surface areas of the products actually disclosed there are given as 530 m²/g (Example 1), 450 m²/g (Example 2), and 600 m²/g (Example 3). In the '556 patent, the surface areas for the zeolite actually disclosed are 530 m²/g (Example 1), 540 m²/g (Examples 2 and 3), and 579 m²/g (Example 4). These figures are, of course, consistent with the surface area of the zeolite Y actually proposed for use in West, *i.e.*, a surface area between about 500 m²/g and 700 m²/g.

It should be emphasized that these surface areas are not the surface areas of the catalysts actually used in the transalkylation procedure of West but the surface areas of the zeolite Y's used as starting materials. These starting materials are increased substantially in surface area to form the catalysts as actually used in the transalkylation reaction. It will be recalled that West requires that

the zeolite Y used as a starting material be treated with water so that the water content of the fresh catalyst is above 3.5 wt.%. Amounts of 5-10 wt.% and 5-15 wt.% are said to be preferred. If one were to select a zeolite Y starting material among the various zeolites actually disclosed in West and the '970 application and '556 patent documents incorporated by reference, the surface area of the starting material would be at least 450 m²/g per Example 2 of the '970 application. Zeolite Y can typically be expected to have a pore volume of about 0.25 to 0.3 ml/g of catalyst, perhaps less. Assuming the minimum amount of water (5%) is added, this would amount to the incorporation of 0.05 ml of water into each gram of zeolite, thus reducing the pore volume by 0.05 ml. For a void volume of the starting catalyst material of .25 ml/g, this would amount to a 20% decrease in pore volume (from .25 ml/g to .20 ml/g), corresponding to a 25% increase in surface area from 450 m²/g to 563 m²/g:

$$\frac{.25 \text{ ml} / \text{g}}{.20 \text{ ml} / \text{g}} \times 450 \text{ m}^2 / \text{g} = 563 \text{ m}^2 / \text{g}$$

Should the pore volume of the zeolite Y catalyst be near the upper end of a typical pore volume, *i.e.* 0.3 ml/g, the corresponding surface area, assuming 450 m²/g of starting material for the zeolite Y actually used in the transalkylation procedure, would be about 540 m²/g.

In view of the foregoing, it is evident that the surface area of the hydrated zeolite Y catalyst actually used in West, if UHP-Y zeolite is used as the starting material, would be well above the maximum surface area of 500 m²/g called for in appellants' independent claims 1, 10 and 18. Further, it is to be recognized that the numbers actually developed above are based on the assumption that one following the teachings of West would select as a starting material a catalyst of a low surface area among the zeolites disclosed in the references and then add water in an amount at the bottom end 5% of the water addition range. Obviously, in viewing the prior art reference as a

whole and considering the many options available in the prior art in terms of surface area of starting material and the amount of water to be added, the surface area of the hydrated zeolite actually used would be well in excess of those surface areas calculated above. It is clear that even making assumptions most favorable to the rejection, there is no overlap, at least in terms of surface area, between appellants' claimed subject matter and the disclosure found in the references.

In view of the foregoing comments, it will be recognized that claims 2 and 3, which specify a surface area for the high porosity zeolite of no more than $400 \text{ m}^2/\text{g}$ or less, clearly are not anticipated or rendered obvious by the patent to West. As a practical matter, it would literally impossible to hydrate the starting material of West to end up with a catalyst actually used in the transalkylation reaction of a surface area of $400 \text{ m}^2/\text{g}$ or less.

Appellants' independent claims 1 and 10 distinguish over West, not only in the recitation of a zeolite Y having a surface area less than that of the hydrated catalyst actually used in West but also in the use of an aromatic alkylation catalyst having a pore size smaller than the average pore size of the low surface area zeolite Y. While West discloses various molecular sieves, including silicalite in addition to zeolite-Y, West, to the extent that it proposes using the so-called UHP zeolite-Y, discloses that this zeolite should be used in both the alkylation and transalkylation reactors. West does not disclose using the designated zeolite-Y in the transalkylation reactor and employing another catalyst, be it silicalite, zeolite, ZSM-5, zeolite- β or the numerous other catalysts disclosed, in the alkylation reactor. To the extent that the Examiner relies upon an admission with respect to prior art (as found in appellants' specification in the section Background of Invention), the discussion there is by no means with respect to the use of the high porosity zeolite-Y disclosed in appellants' specification in combination with other zeolites such as ZSM-5, ZSM-11, or silicalite. In fact, West specifies that the same catalyst be employed in both the alkylation

and transalkylation reactors. To use a UHP zeolite-Y of West in one reactor and a different catalyst in another reactor is simply contrary to the teachings of the reference. It is well established law that obviousness can not be established by modifying a prior art reference in a manner directly contrary to its express teachings, and accordingly for this reason alone, the rejection should be reversed. As noted by the Board of Appeals in *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (POBAI 1984):

The mere fact that a worker in the art could rearrange the parts of the reference device to meet the terms of the claims on appeal is not by itself sufficient to support a finding of obviousness. The prior art must provide a motivation or reason for the worker in the art, without the benefit of the appellant's specification, to make the necessary changes in the reference device.

Here, there clearly is no motivation to one of ordinary skill in the art to attempt to rearrange the West teachings to employ one catalyst in one reactor and another catalyst in another reactor when West proposes that the same catalyst, particularly the UHP zeolite-Y, be employed in both reactors.

Turning specifically to the rejection of claims 10-13 and 18-20 over West et al in view of "admitted prior art" further in view of EP 467,007 to Butler, these claims are submitted to be patentable over the proposed combination of West et al and Butler for the same reasons as advanced above with respect to West standing alone. As noted previously, independent claim 10 requires the use in the alkylation of a molecular sieve having a pore size smaller than the pore size of the high porosity zeolite Y used in the transalkylation reactor. In addition, both independent claims 10 and 18 require that the alkylation reactor be operated in the gas phase in contrast with the West procedure which requires liquid phases in both the alkylation and transalkylation reactor. Further, it is respectfully submitted that the proposed combination of Butler with West (which require the same catalyst in both types of reactors) cannot be made in a manner to arrive at appellants'

invention even if it were proper to use appellants' disclosure as a basis for combining the diverse teachings of the references. However, assuming for the sake of argument that West and Butler could be selectively combined in a manner to arrive at appellants' invention, it is believed clear that this cannot be done in a manner consistent with the proper standard to be applied in combining prior art teachings. This standard forbids using an applicant's own disclosure as a basis for assembling prior art teachings and requires a suggestion or motivation in the prior art as reflected in decisions in *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 221 USPQ 929 (Fed. Cir. 1984) and *Ex parte Giles*, 228 USPQ 886 (PTO Bd. of Appeal. and Int. 1985). As expressed by the Board in *Giles* at 688:

Only appellant's disclosure and not the prior art provides a motive for achieving the combination as claimed by the appellant. To imbue one of ordinary skill in the art with knowledge of the invention . . . when no prior art reference or references of record convey or suggests that knowledge is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.

Attention is also respectfully invited to the Federal Circuit decision in *In re Fine*, 5 USPQ2d 1596 (Fed. Cir. 1988) wherein the Court stated at 1600:

It is essential that "the decisionmaker forget what he or she has been taught at trial about the claimed invention and cast the mind back to the time the invention was made . . . to occupy the mind of one skilled in the art who is presented only with the references, and who is normally guided by the then-accepted wisdom in the art." *Id.* One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. (Emphasis added)

The admonitions in *Ex parte Giles* and *In re Fine* are to step back in time to evaluate the invention only in the context of what is disclosed in the references without regard to what is disclosed in appellants' specification. When this is done, it is believed clear that one of ordinary

skill in the art would not arrive at appellants' invention based only upon the references and "the then-accepted wisdom in the art."

As noted previously, claim 2 and 19 specify that a maximum surface area for the zeolite Y of 400 m²/g, and dependent claim 3 recites the surface area in the range of 350-400 m²/g. It would be literally impossible to hydrate the zeolite Y of precursor material in West and arrive at a zeolite Y molecular sieve for use in the transalkylation reactor meeting these parameters.

Conclusion

For the reasons set forth above, appellants respectfully submit that all of the claims herein are patentable over the prior art. Accordingly, it is respectfully requested that the Final Rejection of the claims be reversed.

Enclosed is a check in the amount of \$310.00 to cover the fee for the filing of this Appeal Brief. The Commissioner is hereby authorized to charge any additional fees that may be due in connection with this Appeal Brief to Deposit Account No. 12-1781.

Respectfully submitted,

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Exhibit A

Claims on Appeal

1. In the alkylation and transalkylation of polyalkylated aromatic compounds, a process comprising:

(a) providing a transalkylation reaction zone containing a transalkylation catalyst comprising a high porosity zeolite-Y molecular sieve having a silica/alumina ratio within the range of 2-5, a pore size greater than 7 and up to about 8 Angstroms, and a surface area of no more than 500 m²/g;

(b) supplying a polyalkylated aromatic component comprising polyalkyl benzenes in which the predominant alkyl substituents contain from 2 to 4 carbon atoms to said transalkylation reaction zone;

10 (c) supplying benzene to said transalkylation reaction zone;

(d) operating said transalkylation reaction zone under temperature and pressure conditions to maintain said polyalkylated aromatic component in a liquid phase and effective to cause disproportionation of said polyalkylated aromatic component to arrive at a disproportionation product having a reduced polyalkyl benzene content and an enhanced mono-alkyl benzene content;

(e) recovering said disproportionation product from said transalkylation zone;

(f) supplying a feedstock containing benzene and a C₂-C₄ alkylating agent to an alkylation reaction zone containing a molecular sieve aromatic alkylation catalyst having an average pore size which is less than the average pore size of said high porosity zeolite-Y;

20 (g) operating said alkylation reaction zone to produce an alkylated product comprising a mixture of mono-alkylated and poly-alkylated aromatic components and benzene by said alkylating agent in the presence of said molecular sieve alkylation catalyst; and

(h) supplying the alkylation product from said alkylation reaction zone to an intermediate recovery zone for the separation and recovery of mono-alkylbenzene from the
25 alkylation product and for the separation and recovery of a polyalkylated aromatic component, including dialkylbenzene, and employing said polyalkylated aromatic component as at least a portion of the polyalkylated aromatic component supplied in subparagraph (b) of claim 1.

2. The method of claim 1 wherein said high porosity zeolite-Y molecular sieve has a surface area of about 400 m²/g or less.

3. The method of claim 2 wherein said high porosity zeolite-Y molecular sieve has a surface area within the range of 350-400 m²/g.

4. The method of claim 1 wherein said polyalkylated benzene comprises alkyl substituents containing 2 or 3 carbon atoms.

5. The method of claims 1 wherein said polyalkylated aromatic component comprises polyethylbenzene.

6. The method of claim 5 wherein at least a portion of the polyethylbenzene is recovered from a transalkylation reaction.

8. The method of claim 1 wherein said alkylating agent contains 2 or 3 carbon atoms.

9. The method of claim 8 wherein said alkylating agent comprises ethylene.

10. In the alkylation and transalkylation process of aromatic compounds, a process comprising:

(a) supplying a feedstock containing benzene into a multistage alkylation reaction zone having a plurality of series connected catalyst beds each containing a molecular sieve aromatic alkylation catalyst having a pore size which is smaller than the average pore size of the hereinafter-recited zeolite-Y;

(b) supplying a C₂-C₄ alkylating agent to said reaction zone;

(c) operating said reaction zone at temperature and pressure conditions to maintain said feedstock in the gaseous phase and causing gas-phase alkylation of said benzene by said alkylating agent in the presence of said catalyst to produce an alkylated product comprising a mixture of monoalkylated and polyalkylated aromatic components;

(d) recovering said alkylated product from said reaction zone and supplying said product from said reaction zone to a benzene recovery zone for the separation of benzene substrate from said alkylated product;

(e) operating said benzene recovery zone to produce a lower boiling benzene containing fraction and a higher boiling fraction comprising a mixture of monoalkylated aromatic and polyalkylated aromatic component,

- (f) recycling benzene from said benzene recovery zone to said reaction zone;
- (g) supplying said higher boiling fraction from said benzene recovery zone to a
20 secondary separation zone;
- (h) operating said secondary separation zone to produce a secondary lower boiling fraction comprising a monoalkylated aromatic component and a higher boiling fraction comprising a heavier polyalkylated aromatic component;
- (i) supplying at least a portion of said polyalkylated aromatic component
25 including the dialkylated and trialkylated aromatics in said polyalkylated component to a transalkylation reaction zone containing a high porosity zeolite-Y molecular sieve having a silica/alumina ratio within the range of 2-5, a pore size greater than 7 and up to about 8 Angstroms, and a surface area of no more than 500 m²/g;
- (j) supplying benzene to said transalkylation zone;
- 30 (k) operating said transalkylation reaction zone under temperature and pressure conditions to maintain said benzene in the liquid phase and effective to cause disproportionation of said polyalkylated aromatic fraction to arrive at a disproportionation product having a reduced polyalkyl benzene content and an enhanced monoalkyl benzene content;
- (l) supplying at least a portion of said disproportionation product to said
35 benzene recovery zone.

11. The process of claim 10 wherein said alkylating agent is an ethylating or propylating agent.

12. The process of claim 11 wherein said alkylating agent is ethylene or propylene.

13. The process of claim 12 wherein said alkylating agent is ethylene.

18. In alkylation and transalkylation of aromatic compounds, a process comprising:

(a) supplying a feedstock containing benzene into a multistage alkylation reaction zone comprising having a plurality of series connected catalyst beds each containing a pentasil molecular sieve aromatic alkylation catalyst;

5 (b) supplying a C₂-C₄ alkylating agent to said reaction zone;

(c) operating said reaction zone at temperature and pressure conditions to maintain said feedstock in the gaseous phase and causing gas-phase alkylation of said benzene by said alkylating agent in the presence of said catalyst to produce an alkylated product comprising a mixture of monoalkylated and polyalkylated aromatic components;

10 (d) recovering said alkylated product from said reaction zone and supplying said product from said reaction zone to a benzene recovery zone for the separation of benzene substrate from said alkylated product;

(e) operating said benzene recovery zone to produce a lower boiling benzene containing fraction and a higher boiling fraction comprising a mixture of monoalkylated aromatic
15 and polyalkylated aromatic component;

(f) recycling benzene from said benzene recovery zone to said reaction zone;

(g) supplying said higher boiling fraction from said benzene recovery zone to a secondary separation zone;

(h) operating said secondary separation zone to produce a second lower boiling
20 fraction comprising a monoalkylated aromatic component and a higher boiling fraction comprising
a heavier polyalkylated aromatic component;

(i) supplying a first portion of said polyalkylated aromatic component including
dialkylated and trialkylated aromatics in said polyalkylated product to a transalkylation reaction
zone containing a zeolite transalkylation catalyst comprising a high porosity zeolite-Y molecular
25 sieve having a silica/alumina ratio within the range of 2-5, a surface area of no more than 500 m²/g,
a pore size greater than 7 and up to 8 and greater than the pore size of said pentasil catalyst;

(j) supplying a second portion of said polyalkylated aromatic component from
said secondary separation zone to a tertiary separation zone which is operated to separate said
heavier polyalkylated aromatic component into a lower boiling fraction of said polyalkylated
30 aromatic component comprising dialkyl and trialkylated aromatics and a higher boiling fraction
comprising a residue fraction;

(k) supplying said lower boiling fraction of said polyalkylated aromatic
component from said tertiary separation zone to said transalkylation reaction zone in addition to said
first portion from said secondary separation zone;

35 (l) supplying benzene to said transalkylation zone;

(m) operating said transalkylation reaction zone under temperature and pressure
conditions to maintain said feedstock in the liquid phase and effective to cause disproportionation of
said polyalkylated aromatic fraction to arrive at a disproportionation product having a reduced
polyalkyl benzene content and an enhanced monoalkyl benzene content: and

40 (n) supplying at least a portion of said disproportionation product to said
benzene recovery zone.

19. The process of claim 18 wherein said alkylation agent is ethylene.
20. The method of claim 19 wherein said high porosity zeolite-Y molecular sieve has a surface area of about 400 m²/g or less.